

## ATOMIC, PERIODIC, AND MOLECULAR HMWK

1. Use the details of modern atomic theory to explain each of the following experimental observations.

- (a) Within a family such as the alkali metals, the ionic radius increases as the atomic number increases.
- (b) The radius of the chlorine atom is smaller than the radius of the chloride ion,  $\text{Cl}^-$ . (Radii : Cl atom =  $0.99\text{\AA}$ ;  $\text{Cl}^-$  ion =  $1.81\text{\AA}$ )
- (c) The first ionization energy of aluminum is lower than the first ionization energy of magnesium. (First ionization energies:  $_{12}\text{Mg} = 7.6\text{ eV}$ ;  $_{13}\text{Al} = 6.0\text{ eV}$ )
- (d) For magnesium, the difference between the second and third ionization energies is much larger than the difference between the first and second ionization energies. (Ionization energies for Mg:  $1^{\text{st}} = 7.6\text{ eV}$ ;  $2^{\text{nd}} = 14\text{ eV}$ ;  $3^{\text{rd}} = 80\text{ eV}$ )
- (e) The radius of the Ca atom is 0.197 nanometer; the radius of the  $\text{Ca}^{2+}$  ion is 0.099 nanometer. Account for this difference.
- (f) A sample of nickel chloride is attracted into a magnetic field, whereas a sample of solid zinc chloride is not.
- (g) Potassium has a lower first-ionization energy than lithium.
- (h) The ionic radius of  $\text{N}^{3-}$  is larger than that of  $\text{O}^{2-}$ .
- (i)  $\text{Ti}^{3+}(\text{aq})$  is colored but  $\text{Na}^+(\text{aq})$  is not.
- (j)  $\text{Ti}^{3+}(\text{aq})$  is a reducing agent but  $\text{Ca}^{2+}(\text{aq})$  is not.
- (k) Where are the exceptions for the ground state configurations for the transition elements?
- (l) Write the electronic configuration for the following atoms: phosphorus, chlorine, zinc, manganese, chromium and copper. Which atoms are paramagnetic and diamagnetic?
- (m) Write the electronic configuration for the following ions:  $\text{N}^{3-}$ ,  $\text{Mg}^{2+}$ ,  $\text{V}^{3+}$
- (n) Write a set of four quantum numbers for each of the valence electrons in a nitrogen atom.
- (o) The first ionization energy for nitrogen atom is larger than the oxygen atom.
- (p) Where are the exceptions for the ground state configurations for the transition elements?

2.  $\text{CO}_2$        $\text{CF}_4$        $\text{XeF}_4$        $\text{NO}_2$        $\text{ClF}_3$        $\text{SeF}_4$        $\text{BF}_3$        $\text{SO}_3$

- (a) Draw a Lewis electron-dot structure for each of the molecules above and identify the shape of each.
- (b) Use the valence shell electron-pair repulsion (VSEPR) model to explain the geometry of each of these molecules.
- (c) Predict whether the molecule is polar or non-polar. Explain your prediction.